*Memorandum*

**To:** Shelley Poticha, Reconnecting America; Valerie Knepper and James Corless, MTC; GB Arrington, PB

**From:** Dominic Spaethling, Kenya Wheeler

**Date:** March 9, 2006

**Subject:** Task 6D, MTC TOD Ridership Analysis

**Introduction**

As a component of the Transit Oriented Development (TOD) Study, the Metropolitan Transportation Commission (MTC) requested an analysis of the potential impact of additional development around transit stations on transit ridership. The overall impact of density on transit ridership was considered in a previous paper[1], along with an examination of several studies that attempt to quantify this relationship.

This memo summarizes the results of a sketch level analysis of the potential impact of increased development and density on transit ridership from areas that are approximately ½-mile from proposed transit stations for several new Bay Area transit corridors identified in MTC Resolution 3434. The purpose of the work is to provide a rough estimate of the level of impact on transit ridership that might occur with additional development adjacent to transit stations.

**Background**

According to MTC, total daily trips in the Bay Area are projected to grow by about 39% between 2000 and 2030. Total daily trips on transit will experience a 53% growth over the same period. This growth will happen as a result of demographic, economic and changing travel needs (See Table 1 comparison of 2000 and 2030 Transit Ridership Data). New transit services will also play a role in the growth of regional transit ridership over time. The following section discusses how the proposed Resolution 3434 corridors will contribute to new transit ridership throughout the region.

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[1] (Memorandum on "Transit Oriented Development: Quantifying Density's Affect on Transit Ridership in the Bay Area", January 19, 2006, prepared by Parsons Brinckerhoff for Reconnecting America).

**Table 1 All Trips by mode 2000 and 2030**

| Mode | 2000 Total Daily Trips (trips / % of total) | 2030 Total Daily Trips (trips / % of total) | Change in Total Daily Trips 2000-2030 (trips) | Percent Change in Trips 2000-2030 (%) |
|---|---|---|---|---|
| **Auto** | 17,074,300 / 84% | 23,626,200 / 83% | 6,551,900 | 38% |
| **Walk** | 1,950,400 / 9% | 2,638,900 / 9% | 688,500 | 35% |
| **Transit** | 1,175,600 / 6% | 1,794,000 / 7% | 618,400 | 53% |
| **Bicycle** | 310,600 / 1% | 402,900 / 1% | 92,300 | 30% |
| **Total** | 20,512,900 / 100% | 28,462,000 / 100% | 7,949,100 | 39% |

Source: MTC and Parsons Brinckerhoff, 2005

**Resolution 3434 Corridors Potential Transit Ridership**

Resolution 3434, adopted by MTC in December 2001, outlined a new Regional Transit Expansion Program as a companion to the 2001 Regional Transportation Plan. Under Resolution 3434, new high capacity bus, ferry and rail transit services will be provided in communities throughout the Bay Area. The new users of these transit services will access these services via a variety of modes, including but not limited to: park-and-ride, kiss-and-ride, bike and shuttle bus. Another source of ridership will be from employees and residents from the area within a half-mile radius of a transit station or stop in each corridor. This analysis examines the potential for changing transit ridership by increasing residential or employment density within a half-mile radius of the station on the Resolution 3434 corridors.

The potential change in transit ridership resulting from new TODs and their associated increased density on Resolution 3434 corridors was examined in a case study of four transit corridors representative of transit corridors in the Bay Area. The four corridors are:

- Dumbarton Rail Corridor, between Union City and Redwood City/East Palo Alto
- BART Extension to Milpitas, San Jose and Santa Clara from Warm Springs Station to Santa Clara Station (BART to San Jose Corridor)
- eBART Corridor from Pittsburg/Baypoint BART Station to Byron
- Sonoma/Marin Area Rapid Transit (SMART) Corridor from Larkspur to Cloverdale

This analysis utilized a methodology to forecast transit ridership generated by the surrounding community based on residential population and employment data and projections for each of the station areas. Transit ridership forecasts use ridership data generated by MTC. These forecasts were processed through equations developed for the Sacramento Area Council of Governments (SACOG) that measure the propensity for residents and/or employees in the surrounding community to use transit based on the density of their community. This analysis only estimates the transit ridership change from the Transit Planning Areas (TPAs), which are the areas surrounding a transit station area where transit-oriented development would be expected to occur. TPAs used in this analysis are generally within a half-mile of a transit station in a Resolution 3434 corridor. Additional detail regarding this methodology can be found in Attachment A: Methodology for an Elasticity Model for the Bay Area TOD Study.

Potential Resolution 3434 corridor ridership is examined under a “base case” (Census 2000) scenario and then compared to two future scenarios: ABAG’s forecasts for Year 2030 (2030 Projections) and the forecasts generated for Year 2020 under the Smart Growth Vision (Vision). The Vision forecasts were developed by regional agencies in concert with other stakeholders as part of the Bay Area Smart Growth Strategy/Regional Sustainability Project in 2002.
MTC used the “Tier 2” list of projects in the 2001 Regional Transportation Plan and the demographic data in the 2030 Projections to generate transit corridor ridership for the 2030 Projections.

This methodology results in the analysis of total transit ridership for Resolution 3434 corridors in 2030 based on three different land use patterns: Current (Census 2000), 2030 Projections and Vision development patterns.

**Results of the Ridership Analysis**

As mentioned above, the change in transit ridership is dependent on the change in population and employment density for each Resolution 3434 TPA. The demographic changes by growth scenario are outlined below in Table 2. The subsequent changes in transit ridership forecasted for each TPA for the Census 2000, 2030 Projections and Vision forecasts are presented in Table 3. The Vision forecasts are based on a high density land use pattern for a 2020-2025 horizon identified through the Smart Growth Strategy process conducted in 2001 and 2002. Under the Vision, downtown and residential areas would have more residential development than is present today. This would significantly increase housing development and result in similar or slightly less employment development than identified under 2030 Projections. It is safe to assume that if the Vision forecasts were extrapolated to 2030 that the higher population densities would result in a greater percentage change in ridership than the 2030 Projections.

Table 3 shows the change in transit ridership between Census 2000, 2030 Projections and Vision demographic projections. MTC's ridership projections using the Year 2030 Projections were used to generate the ridership data. As compared to ridership estimates using Census 2000 (Baseline) land use patterns, approximately 8% to 15% more daily transit trips would occur in the Resolution 3434 Corridor TPAs based on changes in population and employment density identified in the 2030 Projections. An increase in transit trips ranging from 5% to 49% would occur in TPAs under the Vision population and employment projections.

**Table 2: Population and Employment Data for TPAs
By Demographic Forecast**

| Corridor | Year 2000 Population | Year 2000 Employment | Year 2030 Population: Projections | Change in Population 2000 to 2030 | Year 2020 Population: Vision | Change in Population: Projections and Vision | Year 2030 Employment: Projections | Change in Employment 2000 to 2030 | Year 2020 Employment: Vision | Change in Employment: Projections and Vision |
|---|---|---|---|---|---|---|---|---|---|---|
| Dumbarton Rail Corridor | 46,329 | 30,918 | 70,788 | 53% | 94,906 | 34% | 59,614 | 93% | 58,711 | -2% |
| BART to San Jose Corridor | 70,388 | 96,242 | 137,182 | 95% | 227,660 | 66% | 182,756 | 90% | 163,376 | -11% |
| eBART Corridor | 36,961 | 11,634 | 58,727 | 59% | 52,419 | -11% | 25,218 | 117% | 20,383 | -19% |
| SMART Corridor[1] | 49,830 | 55,143 | 67,991 | 36% | 104,864 | 54% | 78,016 | 41% | 69,202 | -11% |

Source: Calthorpe Associates, Parsons Brinckerhoff, 2006

Notes: Year 2000 data from the 2000 Census, U.S. Census Bureau, conducted in 2000; Year 2030 projections are based on the Association of Bay Area Governments (ABAG) 2030 Projections, prepared in 2003; Year 2020 projections are based on the Smart Growth Vision Projections prepared by ABAG for the Smart Growth Strategy Project, prepared in 2002.

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[1] Year 2000 Population data for the SMART Corridor is based on data available in March 2005, when 11 stations were identified in the SMART corridor.

In the case of the Dumbarton corridor, the increase in ridership from the area immediately surrounding the stations (TPAs) is forecast to be between 10% and 13% if the areas develop according to ABAG Projections 2003 for 2030. Ridership from the areas immediately around the stations are forecasted to be higher with the increased levels of development included in the Vision. Depending on the method used for estimating the increased ridership, this figure ranges from 17% to 49%, depending on the assumptions made on the land uses and the shape of the ridership curve.

**Table 3: Change in Transit Ridership within Transit Planning Areas**

| Corridor | Year 2030 Projections over Year 2000 (constrained[1]) | Vision over Year 2000 (constrained, low estimate[2]) | Vision over Year 2000 (constrained, high estimate[2]) | Year 2030 Projections over Year 2000 (unconstrained[1]) | Vision over Year 2000 (unconstrained, low estimate) | Vision over Year 2000 Projections (unconstrained, high estimate) |
|---|---|---|---|---|---|---|
| Dumbarton Rail Corridor | 10% | +17% | +34% | +13% | +24% | +49% |
| BAR T to San Jose Corridor | 9% | +13% | +31% | +15% | +23% | +47% |
| eBART Corridor | 9% | +5% | +17% | +12% | +6% | +19% |
| SMART Corridor | 8% | +12% | +13% | +10% | +18% | +23% |

Source: Calthorpe Associates, Parsons Brinckerhoff, 2006

1 Constrained vs. Unconstrained Ridership Estimates: One of the limitations of the model is that it is not validated in areas where the total population exceeds 7,500 residents within ½ mile of a transit station (or center of the TPA) and 3,000 employed persons within ¼ mile of a transit station (or center of the TPA). Upon initial review of the four case study corridors in the Bay Area, there were several TPAs where the residential and employment development exceeds these thresholds. A revised methodology was applied to estimate transit ridership in those TPAs. In these TPAs, a modified or "constrained" elasticity equation was utilized. TPAs with a total population or employment greater than the threshold for SACOG elasticity equations were analyzed with the ridership elasticity reduced by 50% (from 0.3 to 0.15 for population-based ridership and 0.21 to 0.105 for employment-based ridership). These "constrained" equations were applied to the portion of the TPA within the ½ mile or ¼ mile distance threshold for the appropriate equation.

The "unconstrained" ridership numbers were calculated without this 50% discount rate. The reason for this unconstrained estimate is that other research on TOD generated ridership shows that the influence of density of ridership would not "peak" until well beyond the 7,500 residents within a ½ mile and 3,000 employees within a ¼ mile. For this reason the ridership estimates are shown as a range to reflect the possible ridership estimates for the corridor, based on these two constrained and unconstrained methodologies. This method was developed in order to not overstate the possible ridership estimates for densities that are not statistically validated.

2 The Low Estimate and High Estimate for projections of transit ridership between the Census 2000 and the Vision forecasts are based on the factors used for calculating transit ridership. The first method was based on a forecast of transit ridership that uses a formula based on the primary land use (either Residential or Employment) within each station area. The second method uses the arithmetic mean between the transit ridership forecast formulas for Residential land uses and Employment land uses.

**Conclusions**

Overall transit ridership from within the immediate surroundings of the stations[1] on the four Resolution 3434 corridors would be considerably higher if development occurs consistent with Projections 2030 for increased development around the stations than if the current densities are maintained. The ridership from these immediate areas would be even higher with development and densities consistent with the Vision forecasts.

It must be understood that this analysis provides a very generalized portrait of the potential for changes in development density to affect transit ridership. The model utilized for this study is based on data collected for use in the Sacramento region and while many of the station areas in the Resolution 3434 corridors are similar in density to the Sacramento area, the model does not necessarily consider specific land conditions present in the Resolution 3434 corridors or the Bay Area in general, including but not limited to urban design factors including block size, changes in household type or self selection of residents of communities surrounding transit. In spite of these limitations, this analysis has found that increased residential and employment development around new Bay Area transit services would make a significant impact on transit ridership.

Other similar statistical research conducted by Professor Robert Cervero that focused on the San Francisco Bay Area has found that increases in residential and employment density around transit stations can have an even more profound positive influence on the number of commute transit trips. Cervero's research has also shown that design factors, such as block size when combined with housing density provide an even stronger influence on the potential for increasing commute transit ridership than housing density by itself.[2]

Additional detailed analysis would be necessary in each of the corridors and for each of the stations to accomplish a better understanding of the impact of additional development and density around these transit stations on transit ridership for total transit trips generated by TOD. MTC is continuing its research in this field and will continue to refine its TOD transit ridership models.

[1] Within the TPAs or approximately a half-mile radius of the stations.

[2] Cervero, et. al. Transit-Oriented Development in the United States: Experiences, Challenges, and Prospects. Transportation Research Board: Washington, D.C. 2004. Pages 150-151.

**Attachment A:**

**Methodology for an Elasticity Model for the Bay Area TOD Study**

The need for a simple but credible ridership model for the Bay Area TOD study resulted in the development of a methodology for producing a "sketch-level" estimate of transit ridership, building on the elasticities identified in research from previous transit ridership studies. The Bay Area TOD study will use the following methodology to conduct an assessment of transit usage within the TOD "Transit Planning Areas" (TPAs) and an assessment of the change in transit ridership within transit corridors examined as part of the "case study" phase of the TOD study. TPAs are generally defined as areas within approximately a half-mile of an existing or planned high capacity transit (rail, bus rapid transit or ferry) station. This section will provide an overview of the ridership forecasting method and the demographic data that will be used to generate transit ridership estimates based on population and employment change in TOD areas.

<u>Ridership Change for Regional TOD Growth</u>

The change in transit usage resulting from increased levels of TOD in the Bay Area was calculated using a set of transit ridership elasticities developed in 2004 for SACOG. These elasticities were applied to all TPAs in four case study corridors to generate a projected change in transit ridership levels based on changes in residential population and employment that could occur within the TPAs in the year 2030.

<u>Demographic Forecasts</u>

PB used the following demographic forecasts for population and employment change within TPAs.

- *US Census 2000*
- ABAG *Projections 2003 (2030 Projections)* forecasts
- ABAG *Smart Growth Vision* forecasts (Vision)

Year 2000 data from the 2000 Census was used to create the baseline for comparison between the population and employment densities for TPAs for the year 2000 and the ABAG 2030 Projections and the Vision forecasts.

The 2030 Projections were adopted by ABAG as the regionally approved population and employment forecasts for the 2030 Horizon Year. The 2030 Projections were used by MTC staff to generate transit ridership data for each TPA used in the TOD ridership forecast.

The ABAG *Smart Growth Vision* (Vision) forecasts for demographic change are based on the Regional Livability Footprint/Smart Growth Strategy Project completed by ABAG and MTC in 2002. These forecasts were based on the conceptual development patterns, and associated densities and land use patterns identified in the preferred scenario for the Vision project. For consistency with other deliverables for the MTC TOD Study, the Vision projections are used for this forecast. However, the Vision projections are not directly comparable because they are based on a loosely defined future concept; we have described the as roughly comparable to development expected for the Year 2020.

# Transit Ridership Estimation Method

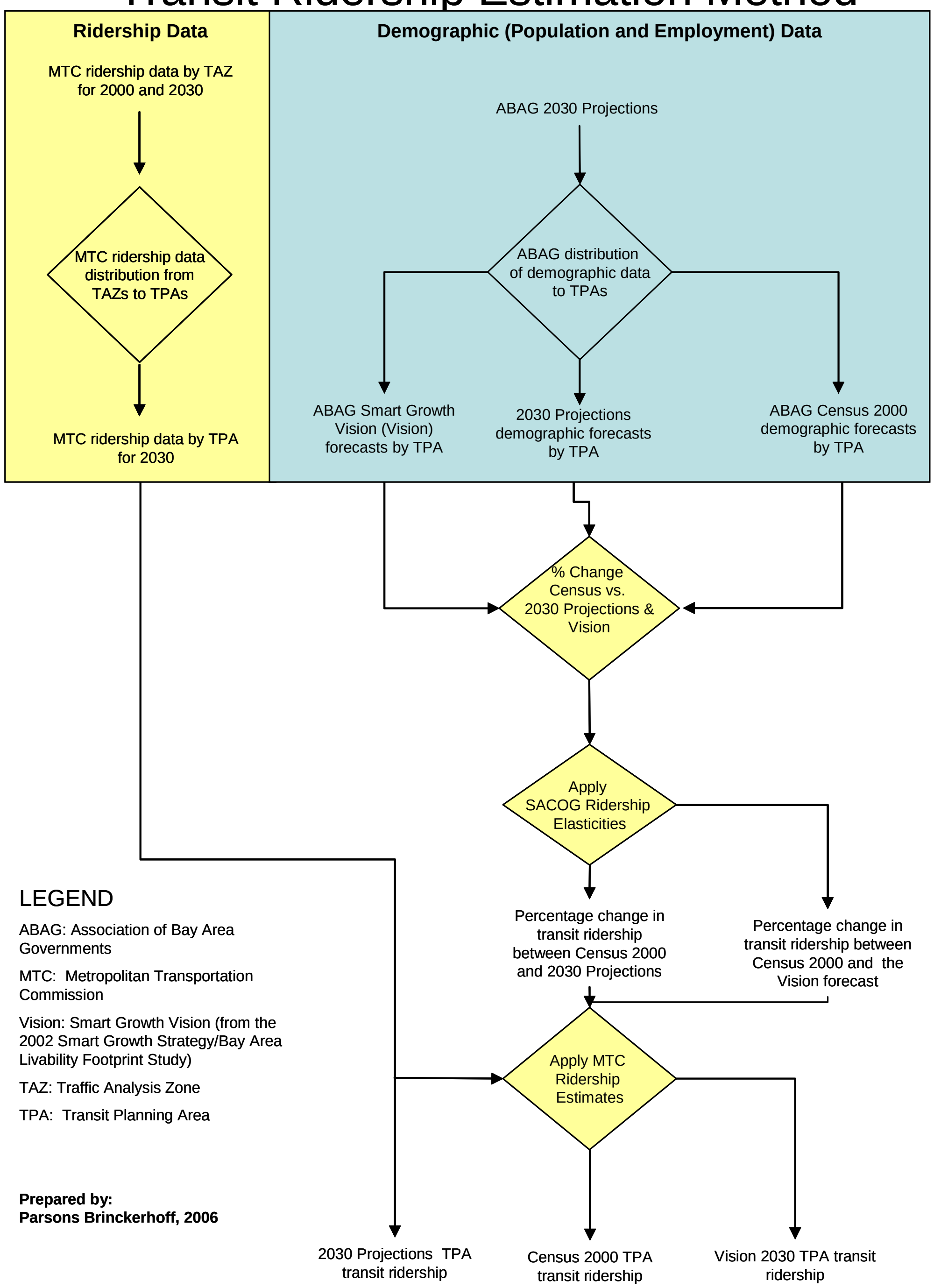


**Figure 1**

Method for the Application of the Ridership Elasticity Model

The SACOG ridership elasticity model was applied using the general method described above and illustrated in Figure 1. Demographic data was obtained for each TPA, with the 2030 Projections forecast for 2030 serving as the demographic "baseline" for ridership forecasts. Data was also obtained for the Vision employment and population projections. The rate of change in population and employment was calculated for each TPA and applied to the appropriate elasticity measure. This generated a "weighted" elasticity for each TPA based on the population or employment change. PB used ridership data provided by MTC from the 2030 regional travel demand model to create an order of magnitude transit ridership number based on the change in population and employment density changes in the TPA's areas for the three demographic data sets outlined above. This method was used to develop the percent ridership change for the case study corridors outlined in the following section.

Ridership Change for Case Study Corridors

The potential change in transit ridership resulting from new TODs on Resolution 3434 corridors was examined in a case study of four transit corridors representative of transit corridors in the Bay Area. Four corridors were identified in February 2005 for the case study analysis:

- Dumbarton Rail Corridor, between Union City and Redwood City/East Palo Alto
- BART Extension to Milpitas, San Jose and Santa Clara from Warm Springs Station to Santa Clara Station (BART to San Jose Corridor)
- eBART Corridor from Pittsburg/Baypoint BART Station to Byron
- Sonoma/Marin Area Rapid Transit (SMART) Corridor from Larkspur to Cloverdale

This analysis utilized residential or employment population data and projections for each of the station areas for the radii appropriate to each elasticity equation. Corridor ridership was calculated based on the aggregation of the individual station data. The results of this analysis were used to generate transit ridership projections for the level of development envisioned as part of the Census, 2030 Projections and Vision forecasts in each of the case study corridor.

Constrained vs. Unconstrained Ridership Estimates

The case studies follow the methodology outlined above. However, one of the limitations of the model is that it is not validated in areas where the total population exceeds 7,500 residents within ½ mile of a transit station (or center of the TPA) and 3,000 employed persons within ¼ mile of a transit station (or center of the TPA). Upon initial review of the four case study corridors in the Bay Area, there were several TPAs where the residential and employment development exceeds these thresholds. A revised methodology was applied to estimate transit ridership in those TPAs In these TPAs, a modified or "constrained" elasticity equation was utilized. TPAs with a total population or employment greater than the threshold for SACOG elasticity equations were analyzed with the ridership elasticity reduced by 50% (from 0.3 to 0.15 for population-based ridership and 0.21 to 0.105 for employment-based ridership). These "constrained" equations were applied to the portion of the TPA within the ½ mile or ¼ mile distance threshold for the appropriate equation. This method was developed in order to not overstate the possible ridership estimates for densities that are not statistically validated.

The "unconstrained" ridership numbers were calculated without this 50% discount rate. The reason for this unconstrained estimate is that other research on TOD generated ridership shows that the influence of density of ridership would not "peak" until well beyond the 7,500 residents within a ½ mile and 3,000 employees within a ¼ mile. For this reason the ridership estimates are shown as a range to reflect the possible ridership estimates for the corridor, based on these two constrained and unconstrained methodologies.